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STORE LIGHTING

A Discussion of Various Types of Lighting Systems with Suggestions and Tables of Particular Application in Store Lighting Problems

Good Engineering may be Combined with Good Taste to Produce
an Excellent Lighting Installation

Store Lighting

For consideration of their lighting requirements, stores may be divided into four classes:

1.—Department stores, and the large specialty stores of our principal cities;

2.—Medium-sized stores, including the large stores of the smaller cities;

3.—Small select stores and shops;

4.—Small stores of the usual type.

In stores of the first named class, the lighting requirements are very similar, although the location of stores, their size, and the individual preferences of their owners will, of course, cause considerable variation in the design of lighting installations. Such stores are usually imposing establishments and the lighting equipment should assist in furthering the impression created by the store as a whole. On the main floor, especially, a high intensity of light and a pleasing appearance of equipment are necessary.

For stores of medium size, in which class it will be noted are included the large stores of the smaller cities, the system provided should possess distinctive and decorative features, but these should be obtained with due regard to the efficient utilization of the light.

In the select small store or shop, great freedom is usually permissible in the selection of a lighting system; good appearance and a pleasing effect are the important considerations.

For the usual small store, elaborate lighting is not required; rather, the system should supply plenty of light efficiently.

Types of Lighting Systems

All modern methods of illumination are adapted to store lighting, although some systems, such as those employing steel reflectors, find only a limited application. The systems in common use are:

The indirect system, in which all the light from the fixture first lights the ceiling, whence it is diffused throughout the room. The units themselves usually appear dark unless equipped on the underside with an auxiliary diffusing bowl illuminated from within. The exterior of the unit may be of any shape or material

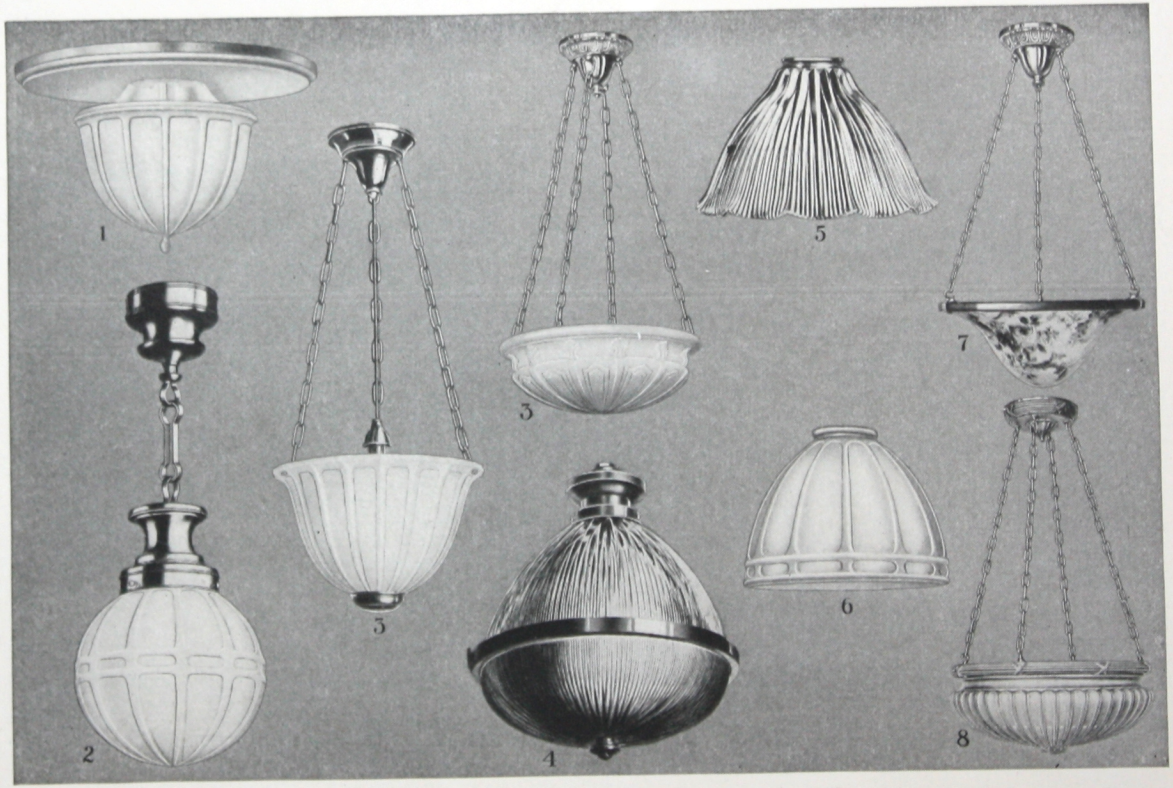

Fig. 1—Types of Store Lighting Units

1—Semi-Enclosing Unit.
2—Opal Enclosing Unit.
3—Opal Semi-IndirectUnits.
4—Prismatic Enclosing Unit.
5—Prismatic Open Reflector.
6—Opal Open Reflector.
7—Prismatic Semi-Indirect Unit.
8—Mirrored-Glass Indirect Unit.

desired, but the interior reflecting surface is usually mirrored glass or porcelain enamel.

The semi-indirect system, in which the greater part of the light first strikes the ceiling as in a totally indirect system and a smaller part is transmitted through the bowl, which may be of alabaster or of opal or prismatic glass.

The direct-lighting system, in which are used either totally enclosing or semi-enclosing globes completely screening the lamp from view, or open reflectors designed to diffuse and direct the light and to protect the eye. Direct lighting units commonly used in store lighting are of the opal or prismatic glass type.

In considering any form of lighting system, it should be borne in mind that improvements in incandescent lamps have resulted in decreasing the size of the light source and increasing its brilliancy; hence, it is more than ever necessary to take precautions to protect the eye from the filament. MAZDA lamps, up to and including the 200-watt size, should always be bowl-frosted when used in open reflectors. When lamps larger than 200 watts are to be used, bowl-frosting will not reduce the brilliancy sufficiently for comfortable vision and in such cases some form of enclosing, semi-indirect, or totally indirect unit should be selected.

Typical units of the classes referred to above are shown in Figs. 1 and 2. Photographs of good store lighting installations are reproduced in succeeding pages.

Department and Large Specialty Stores

For the main floor of a department or large specialty store, a system of enclosing units or of some form of semi-indirect or totally indirect units is preferable to a system employing open reflectors. With the exception of the prismatic type, totally enclosing units do not provide a high degree of light control, and the maximum candle-power is usually in a direction near the horizontal. In order to avoid undue glare, the units should be of large area and highly diffusive. A portion of the light from these units is transmitted directly to the objects beneath, and another portion reaches them by reflection from the ceiling, but the efficiency of an opal enclosing unit system will not be materially higher than that of a good totally indirect system, except where the ceiling is finished in an unusually dark color; for with the opal units a large percentage of

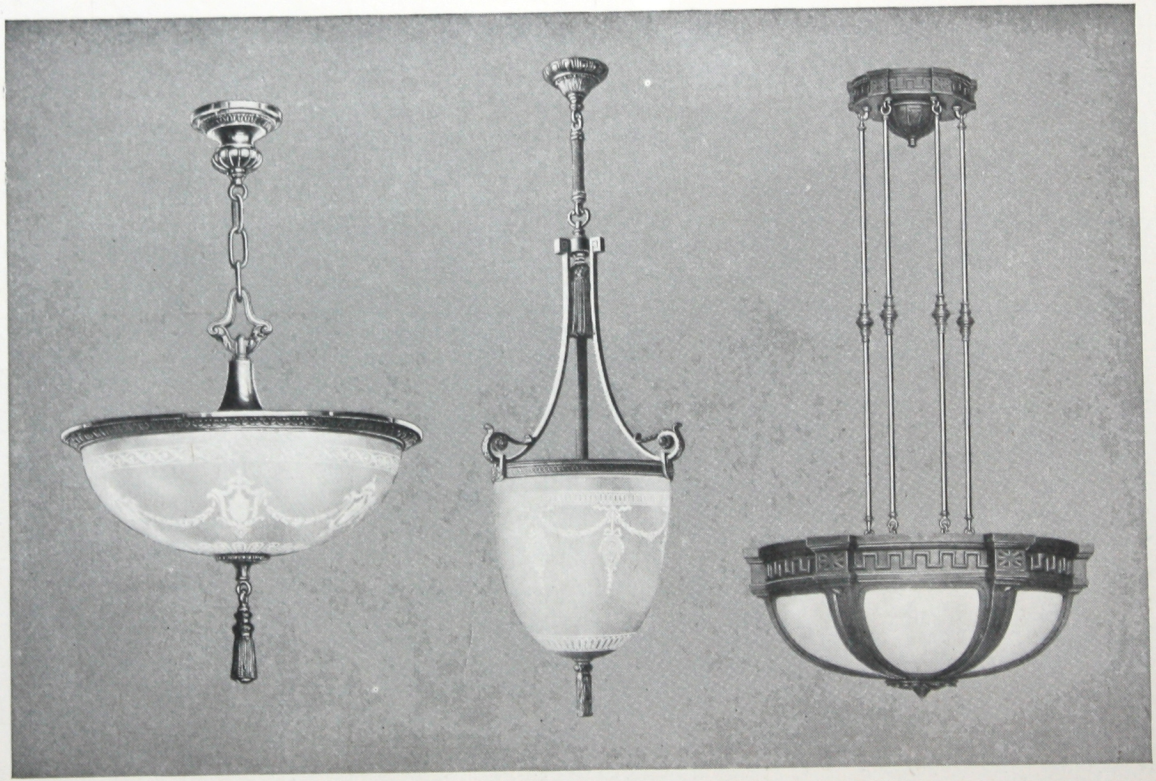

Fig. 2—Decorative Design is Entirely Compatible with Good Engineering

The efficiency of the luminous-bowl unit on the right is but little impaired by the massive, metal decorations, for the bowl supplies only a very small portion of the illumination. On the other hand, the same decorations applied to the semi-indirect or enclosing units illustrated would not only produce unpleasant contrasts but would absorb a considerable portion of the light.

the light flux is emitted at angles near the horizontal and never reaches the counters. Light emitted near the horizontal does, however, serve a very useful purpose in that it illuminates vertical or inclined surfaces, such as shelves, racks, etc., which if lighted only from directly above would be inadequately illuminated. Enclosing units are obtainable in a wide variety of shapes and sizes ranging from very inexpensive to very costly and exclusive designs, which features have led to their common use in all classes of stores. Prismatic-glass enclosing units produce much the same lighting effect as open reflectors, with which they compare favorably in efficiency; they possess, however, the advantages of being more decorative and of properly screening the filament of the lamp from view.

From the standpoint of comfortable vision, indirect and semi-indirect units are more desirable for the main floors of department stores than are enclosing units. With strictly indirect systems, where the ceiling acts as the light source and there is a pronounced downward direction to the light, the uniformity and diffusion of the illumination are excellent, glare from the light source is absent, and reflections from plate glass and polished fixtures are avoided; however, shadows, which, if of the proper density, are a great aid in judging the shape and proportions of an object, may be too greatly reduced. The direction of the light, moreover, tends to make vertical surfaces appear poorly lighted. Since the illumination of the room is entirely dependent upon reflected light from the ceiling, the efficiency of the system will be highest if the ceiling is finished in white. However, with the present low cost of light, a tinted ceiling is justified where essential to the decorative scheme of the room or where lighting of a certain color tone is desired.

The luminous-bowl type of indirect unit produces the same general character of illumination as that produced by strictly indirect units, but the auxiliary bowl, being luminous, gives a direct component which assists slightly in illuminating vertical surfaces, and, in the opinion of many, adds to the decorative value of the installation.

Semi-indirect units of dense or toned glass give an effect very similar to that given by luminous-bowl indirect units, but they transmit a higher percentage of the light, and are, under usual conditions, slightly more efficient. With bowls of light density, the results approach more nearly those obtained from opal-glass enclosing units; contrary to what might be expected, however, the semi-indirect system is often more efficient due to the fact that less light is absorbed by the bowl, less light is emitted

Fig. 3—Main Floor of a Department Store Lighted With Opal Enclosing Units. See Fig. 4

Fig. 4—Upper Floor of Department Store Shown in Fig. 3 Lighted With Open Opal Reflectors

Fig. 5—Indirect Units Which Harmonize With the Interior Decorations Are Used in This Department Store

Fig. 6—Semi-Indirect Units in Department Store Lighting. Contrasts of Light and Shade on the Ceiling May be Controlled by Dipping the Lamps in an Etching Solution

in angles near the horizontal, and more light is directed to and diffused from the ceiling at effective angles.

It is possible to obtain either indirect or semi-indirect bowls in exclusive designs harmonizing with the decorations and conforming to the tastes of the user; regardless of the design of the exterior, however, it is of the utmost importance that the interior be a hard, smooth reflecting surface in order that good efficiency may be maintained. In an installation which runs into any considerable expenditure, it is well worth while to secure the opinion of a competent architect or decorator before determining upon a definite exterior design.

Lighting units of the same general type as are used on the main floor are suitable for the upper floors of large stores; often a smaller size of the same design may be chosen. In some cases, a well designed direct-lighting system may meet the requirements satisfactorily. With open reflectors, bowl-frosted lamps should always be installed and the units should be suspended at such a height that they will be, as nearly as possible, outside the range of ordinary vision. As previously stated, MAZDA lamps of larger than 200 watts should not be used in open reflectors. Semi-enclosing units are available, however, which operate on much the same principle as an open reflector but which are provided with a diffusing glass bowl below the reflector which screens the lamp from view. With such units, any size of lamp may be used. Their efficiency compares favorably with that of the prismatic type of enclosing unit.

On all floors, the fixtures should be located symmetrically with respect to the divisions or bays usually formed in the ceiling by the constructional features of the building, unless it is desired to arrange the lighting to enhance some architectural effect in light and shade, or color, in accordance with a skillful designer's well considered plan.

Stores of Medium Size

The lighting requirements of stores of medium size are the same as those cited for large stores, except that a location amid less impressive surroundings may decrease the need for purely decorative features. In this class of store, a semi-indirect system employing some form of inexpensive medium-density bowl will often fully meet the requirements of a distinctive and economical installation. A well designed direct-lighting system, such as might be used on the upper floors of large stores, is very frequently deemed entirely

satisfactory,—especially where a semi-enclosing unit, of which No. 1, Fig. 1, is a type, is used.

Exclusive Stores

Exclusive small stores or shops, found principally in the larger cities, lend themselves to an artistic treatment which is impossible in larger areas. In many cases, the use of colored lamps to provide lighting of a distinctive tone is highly desirable, while uniformity of illumination is to be avoided rather than sought. The fixtures may well be of special design but care should be taken to avoid the very common error of allowing too brilliant light sources within the range of vision. Modifications of semi-indirect, indirect, and enclosing fixtures are used almost entirely. A prismatic glass semi-indirect unit has been recently developed which consists of two glass bowls between which may be placed flowered silk, cretonne, or other decorative fabric of any pattern desired. The prisms, which line the outer surface of the inner bowl where they are protected from dust, insure an efficient distribution of the light; the decorative fabric may be changed at will.

Small Stores in General

Efficiency is the first requirement of a lighting system for the usual small store. A high intensity is necessary for the convenience of customers and for advertising purposes, but the fixtures may be of very simple design. Consequently, direct lighting with open reflectors of the prismatic or dense-opal type, or with a good type of semi-enclosing unit, is, as a rule, most applicable although often the installation of an inexpensive semi-indirect or enclosing unit is preferable.

Semi-enclosing units possess an advantage over open reflectors in that they diffuse the light from the filament over a comparatively large area; hence they may be used with any size of lamp, and in locations where open reflectors would cause annoying glare. They possess an advantange over opal enclosing units in that they distribute light in much the same way as a dense opal open reflector and are therefore less dependent for their efficiency upon the finish of the walls and ceiling.

A common mistake in small store lighting is the installation of a single row of direct-lighting reflectors along the center of the store, where at least two rows of smaller units should be used to prevent the customer's shadow from interfering with his examination of

Fig. 7—A Specialty Store Lighted with Totally Enclosing Opal Units

Fig. 8—A Specialty Store Lighted with Semi-Indirect Units. Note the Color-Matching Units Suspended Over the Necktie Show Case

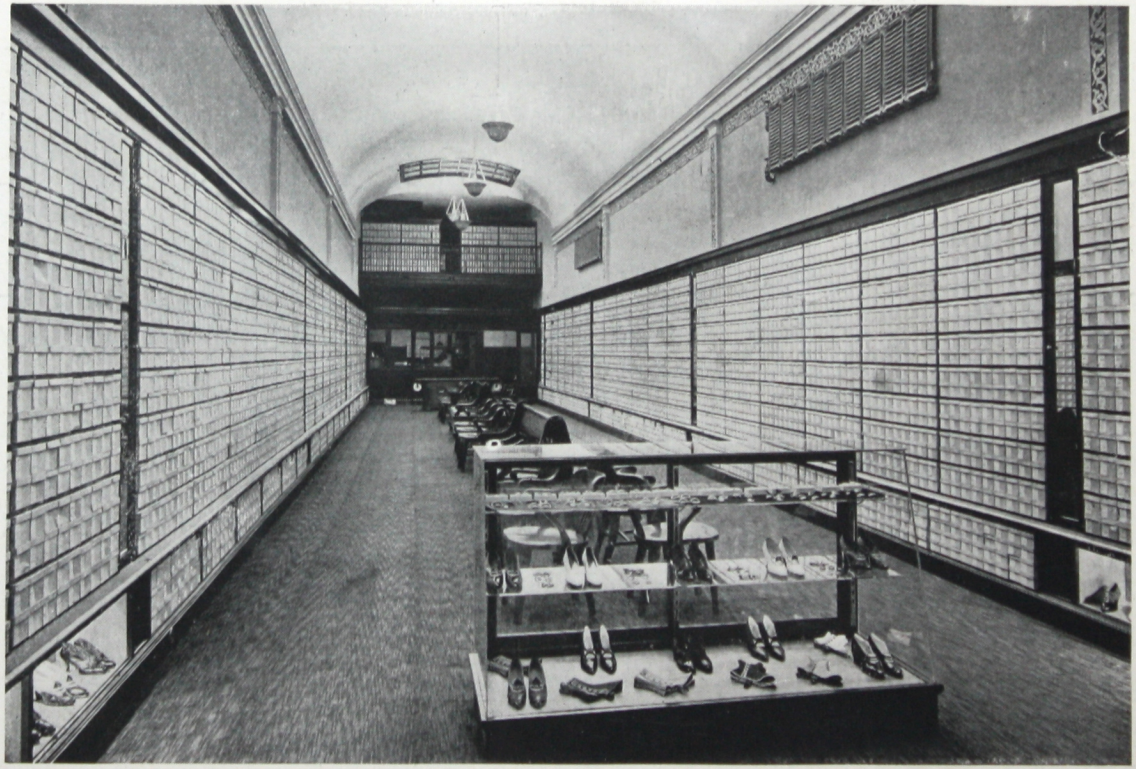

Fig. 9—An Attractive Store Well Lighted

Fig. 10—Semi-Indirect Lighting Supplemented by Wall Brackets in a Specialty Store

Fig. 11—Indirect Lighting of a Small Shop

the wares, and to illuminate the shelving or high cases along the sidewalls. A single row of semi-indirect or enclosing units is, however, usually satisfactory. An exception to the use of bowl-frosted lamps with open reflectors may be made in the case of small jewelry stores where brilliant reflections in gems and cut glass may be desirable; the units should, however, be placed well above the usual line of vision to avoid glare.

Illumination Intensities

A lighting installation serves a double purpose: first, it permits the merchandise to be examined with comfort; second, it advertises the store. Light is recognized as one of the least expensive and most effective advertising mediums, and hence intensities higher than absolutely necessary for comfortable vision are almost universally demanded. The three factors which govern the selection of an intensity for any particular case are: the nature of the merchandise—for dark goods require a higher intensity than light goods to appear equally well illuminated; the illumination standard of the immediate neighborhood; and, the amount which the owner feels it expedient to apportion for the advertising value of a high intensity. The lower values of any table of intensities should, therefore, be used cautiously and full weight given to local conditions. However, values applying to average conditions are useful as a basis upon which to estimate desirable intensities, and such values are given in Table 1.

Coefficients of Utilization

Intensities of illumination are commonly expressed in foot-candles and are not in themselves measures of the total quantity of light. To determine the quantity of light required to provide a given average intensity, it is only necessary to multiply the area in square feet of the surface to be illuminated by the desired intensity in foot-candles; the result will be the quantity of light flux, or lumens, which must be supplied to the area to produce the desired foot-candles intensity. Obviously, if just sufficient wattage is installed to supply the number of lumens so calculated, the illumination will fall far short of the desired value because of the light flux which will be absorbed by the reflector equipment and by the ceiling and vertical surfaces. The proportion of the light flux generated by the lamps which is effective in illuminating the "working plane," that is, an imaginary surface parallel to the floor and at a height of

2½ to 3 feet above it depending upon the height of counters, cases, goods, etc., depends upon the type of fixture selected, the color of the ceiling and walls, and the size of the room. Ceilings in stores are usually fairly light in color and the walls are, in most cases, lined with shelves; hence, it is possible to give values for the proportion of light which is effective in illuminating the working plane for various reflector equipments for the different classes of stores. These values, which are called coefficients of utilization, are given, as fractions of the total light of the bare lamps, in Table 2.

Calculation of the Required Wattage

In calculating the wattage required for a certain store, the first step is to decide, at least tentatively, upon the type of fixture, in accordance with the general principles discussed above. The second step is to decide upon the intensity in foot-candles which will be needed on the working plane; Table 1 will be found helpful in determining this intensity. The third step is to determine the lumens required to produce this intensity; this is calculated by multiplying the area of the room in square feet by the intensity in foot-candles. The fourth step is to divide the calculated number of lumens by the coefficient of utilization, expressed as a fraction; this fraction may be obtained from Table 2. The result obtained will be the number of lumens which the lamps must furnish to give the desired intensity. In order to take care of the decrease from initial to average light output of the lamps, the number of lumens so calculated should be increased by 10 per cent. A further number should be added to allow for depreciation due to the collection of dust upon the lamps, reflectors, ceiling, and walls. It is of great importance that a schedule providing for regular and frequent cleaning be adopted, but even where units are cleaned thoroughly once a month, 10 per cent additional lumens should be allowed for dust depreciation. The final value, then, represents the lumens which the bare lamps should provide initially.

The lumens initially given by the MAZDA lamps commonly used in store lighting are given in Table 3. With the total lumens known, the required number of lamps of any given wattage may be readily approximated by reference to Table 3.

Size of Lamp, Hanging Height, and Spacing Distance

Of the lamps which will supply the required quantity of light, the size to be chosen depends upon the ceiling height and upon the type of fixture selected, i. e., whether the fixture distributes the

Table No. 1

Range of Foot-Candle Intensities Desirable for Various Classes of Service

Department Stores and Large Specialty Stores

Main Floors	6–10	Other Floors	4–7

Stores of Medium Size

Book and Stationery	3–6	Dry Goods	4–7
Clothing	4–7	Furniture	3–5
Drug	4–6	Grocery	3–5

Exclusive Small Stores

Light Goods	6–10	Dark Goods	8–12

Small Stores in General

Art	5–8	Furrier	5–7
Book	3–5	Grocery	3–4
Bake Shop	3–4	Haberdashery	5–7
Butcher	3–4	Hardware	3–4
Cigar	4–6	Hat	4–6
Clothing	4–7	Jewelry	4–6
Confectionery	3–5	Millinery	4–6
Decorator	4–5	Notions	3–5
Drug	3–6	Shoe	3–4
Dry Goods	4–7	Tailor	4–7
Florist	3–4		

Table No. 2

Fraction of Total Light from Lamps which is Effective in Stores of Different Sizes Light Ceiling and Medium Walls Assumed

Type of Lighting Unit; Numbers Correspond to Those of Fig. 1		Department and Large Specialty Stores	Stores of Medium Size	Small Stores
Open Prismatic, No. 5		0.55	0.45	0.35
Open Opal, No. 6	Dense	0.53	0.44	0.35
	Light	0.48	0.40	0.30
Semi-Enclosing, No. 1		0.49	0.41	0.32
Totally Enclosing Prismatic, No. 4		0.46	0.40	0.33
Totally Enclosing Opal, No. 2		0.43	0.34	0.24
Semi-Indirect Opal, No. 3	Dense	0.42	0.35	0.25
	Light to Med.	0.45	0.38	0.28
Semi-Indirect Prismatic, No. 7		0.42	0.35	0.25
Totally Indirect Mirrored Glass, No. 8, Opaque or Luminous Bowl		0.38	0.32	0.22

Table No. 3

Lumen Output of the 110-125 Volt MAZDA Lamps Commonly Used for Store Lighting These Data are Subject to Change Without Notice

MAZDA B		MAZDA C		MAZDA C-2	
Watts	Lumens	Watts	Lumens	Watts	Lumens
		75	865	75	600
10	75	100	1260	100	870
15	128	150	2050	150	1400
25	226	200	2800	200	2000
40	372	300	4600	300	3350
50	472	400	6150	500	5600
60	575	500	8050	...	...
100	995	750	12800	...	...
		1000	18000	...	...

light over a large or a small area. Enclosing units and open reflectors should, as a rule, be suspended as high above the floor as is consistent with good appearance in order that the light sources may be as far removed as possible from the range of vision. This allowable hanging height determines the permissible spacing of units of any given type for reasonable uniformity of illumination. The maximum ratios of the spacing distance to the height of the unit above the working plane (not above the floor), which may be used with fair uniformity of illumination with the various types of units discussed in this bulletin, are given in Table 4. If greater spacing distances than those determined by these ratios seem desirable, it should be remembered that as the spacing is increased the degree of uniformity decreases rapidly. The greater the permissible spacing distance, the larger the lamps which may be used and the fewer the number required. The fewer the units of a given type, the less the installation and operating expense, but the greater the area affected by the failure of a lamp and the denser the shadows. However, if the ratios given in Table 4 are not exceeded, no trouble from this source need be anticipated. It should be noted that conditions governing the hanging height and spacing distance for indirect and semi-indirect units are somewhat different since in installations of this type, the ceiling acts as the light source. The hanging height may, in such installations, be chosen from considerations of convenience and appearance but it should be borne in mind that if units are hung close to the ceiling, the areas directly above the units will be brightly lighted in contrast to intermediate areas; this effect may be considered desirable or it may be considered undesirable, depending upon the effect which it is desired to produce. Shadows cast by the bowl of the unit and by the suspension rods or chains may, if considered objectionable, be eliminated by dipping the lamps in an etching solution. The spacing distance is determined by the height of the ceiling since the ceiling acts as the light source.

As previously mentioned, it may be desirable to obtain special light and shade effects in certain instances; where this is the case, the rules given above do not, of course, apply.

Example of Illumination Design

It is desired to design the lighting system for the main floor of a department store which measures 150 feet long by 100 feet wide. The ceiling is 16 feet above the floor and finished in white. Four

Table No. 4

Data on Spacing of Units for Uniformity of Illumination

Equipment	Ratio — Maximum Allowable Spacing Distance / Height Above Plane
Open Prismatic Intensive	1.40
Open Prismatic Focusing	0.75
Open Opal	1.60
Semi-Enclosing	1.40
Totally Enclosing Prismatic	1.50
Totally Enclosing Opal	1.60
Semi-Indirect	1.50*
Indirect, Opaque or Luminous Bowl	1.50*

*Height is distance between ceiling and plane of illumination; see page 22.

Table No. 5

Technical Data on 110-125 Volt MAZDA Lamps
Subject to Change Without Notice

Watts	Watts Per Spherical Candle-Power	Lumens Per Watt	Total Lumens	Bulb: Type	Bulb: Diam. in Inches	Maximum Over-All Length, Inches	Base	Standard Package Quantity	Position of Burning	Rated Average Life, Hours
Straight-Side MAZDA B Lamps										
10	1.67	7.52	75	S-17	2⅛	4⅝	Med. Screw	100	Any	1000
15	1.47	8.55	128	S-17	2⅛	4⅝	Med. Screw	100	Any	1000
25	1.39	9.04	226	S-19	2⅜	5¼	Med. Screw	100	Any	1000
40	1.35	9.31	372	S-19	2⅜	5¼	Med. Screw	100	Any	1000
50	1.33	9.45	472	S-19	2⅜	5¼	Med. Screw	100	Any	1000
60	1.31	9.59	575	S-21	2⅝	5½	Med. Screw	100	Any	1000
100	1.26	9.97	995	S-30	3¾	7⅞	Med. Sc. Sk.	24	Any	1000
Pear-Shape MAZDA C Lamps										
75	1.09	11.53	865	PS-22	2¾	6⅛	Med. Screw	50	Any	1000
100	1.00	12.57	1260	PS-25	3⅛	7⅛	Med. Screw	24	Any	1000
150	0.92	13.66	2050	PS-25	3⅛	7⅛	Med. Screw	24	Any	1000
200	0.86	14.61	2920	PS-30	3¾	8⅜	Med. Screw	24	Tip Down	1000
300	0.78	16.11	4850	PS-35	4⅜	9¾	Mog. Screw	24	Tip Down	1000
400	0.82	15.32	6150	PS-40	5	10	Mog. Screw	12	Tip Down	1000
500	0.78	16.11	8050	PS-40	5	10	Mog. Screw	12	Tip Down	1000
750	0.74	16.98	12800	PS-52	6½	13⅜	Mog. Screw	8	Tip Down	1000
1000	0.70	17.95	18000	PS-52	6½	13⅜	Mog. Screw	8	Tip Down	1000
Pear-Shape MAZDA C-2 Lamps										
75	1.58	8.0	600	PS-22	2¾	6⅛	Med. Screw	50	Any	700
100	1.44	8.7	870	PS-25	3⅛	7⅛	Med. Screw	24	Any	700
150	1.34	9.4	1400	PS-25	3⅛	7⅛	Med. Screw	24	Any	700
200	1.25	10.1	2000	PS-30	3¾	8⅜	Med. Screw	24	Tip Down	700
300	1.12	11.2	3350	PS-35	4⅜	9¾	Mog. Screw	24	Tip Down	700
500	1.12	11.2	5600	PS-40	5	10	Mog. Screw	12	Tip Down	700
Round-Bulb MAZDA B Lamps										
15	1.53	8.21	123	G-18½	2 $\frac{5}{16}$	3¾	Med. Screw	100	Any	750
15	1.43	8.79	132	G-25	3⅛	4¾	Med. Screw	50	Any	750
25	1.45	8.67	222	G-18½	2 $\frac{5}{16}$	3¾	Med. Screw	100	Any	750
25	1.35	9.31	240	G-25	3⅛	4¾	Med. Screw	50	Any	750
40	1.33	9.45	386	G-25	3⅛	4¾	Med. Screw	50	Any	750
60	1.23	10.22	630	G-30	3¾	5½	Med. Screw	24	Any	750
100	1.18	10.65	1100	G-35	4⅜	7¼	Med. Sc. Sk.	24	Any	750

beams running lengthwise of the store and six running crosswise divide the ceiling into 35 bays, each measuring approximately 20 by 21½ feet. The store is located in the main business district of a large city and the management is favorably impressed with the appearance of a semi-indirect lighting unit of medium-density glass, which, in addition to providing well diffused illumination, will give to the store a bright and attractive appearance.

By reference to Table 1, it is seen that from 6 to 10 foot-candles is the desirable range of intensities for the main floor of a department store. Since this store is located in the principal business district, the latter figure will be selected.

Multiplying the length of the store by the width, the area is found to be 15,000 square feet. Multiplying this result by 10, the foot-candle intensity desired, it is found that 150,000 lumens will be required on the working level. The fraction of the total light from the lamps which is effective when medium-density semi-indirect units are used in a department store with ceiling and walls of the usual tones, is found from Table 2 to be 0.45. Dividing the number of lumens required on the working level, 150,000, by this fraction, the number of lumens which the lamps must give is found to be slightly in excess of 333,000. In order to compensate for the decrease in light from initial to average output of the lamps, this value is increased, by 10 per cent, to 366,300. A further allowance of 10 per cent is made for decrease in light due to the accumulation of dust, so that the bare lamps required for the installation should initially provide 403,000 lumens.

The fact that the ceiling of this store is divided into rectangular bays, makes it desirable to provide a symmetrical arrangement of units with respect to each bay. The simplest and probably the most attractive method is to install one unit per bay, provided that sufficient uniformity of lighting will be obtained. If one unit is to be used to each of the 35 bays, each lamp must supply 11,500 lumens. Upon referring to Table 3, it is found that the 750-watt MAZDA C lamp, giving 12,800 lumens, comes the nearest to fulfilling the requirements, and this lamp is selected.

As previously explained, the ceiling acts as the light source in indirect lighting and the maximum spacing permissible between units depends upon the ceiling height. In the problem at hand, the ceiling height is 16 feet, and the height above the working plane is 13½ feet. By reference to Table 4, it is seen that for this height the spacing between semi-indirect units should not

Fig. 12—A Small Shop Illuminated by Floor Lamps of the Indirect Type

Fig. 13—A Grocery Lighted with Semi-Enclosing Units

Fig. 14—A Small Grocery Lighted with Opal Open Reflector Units

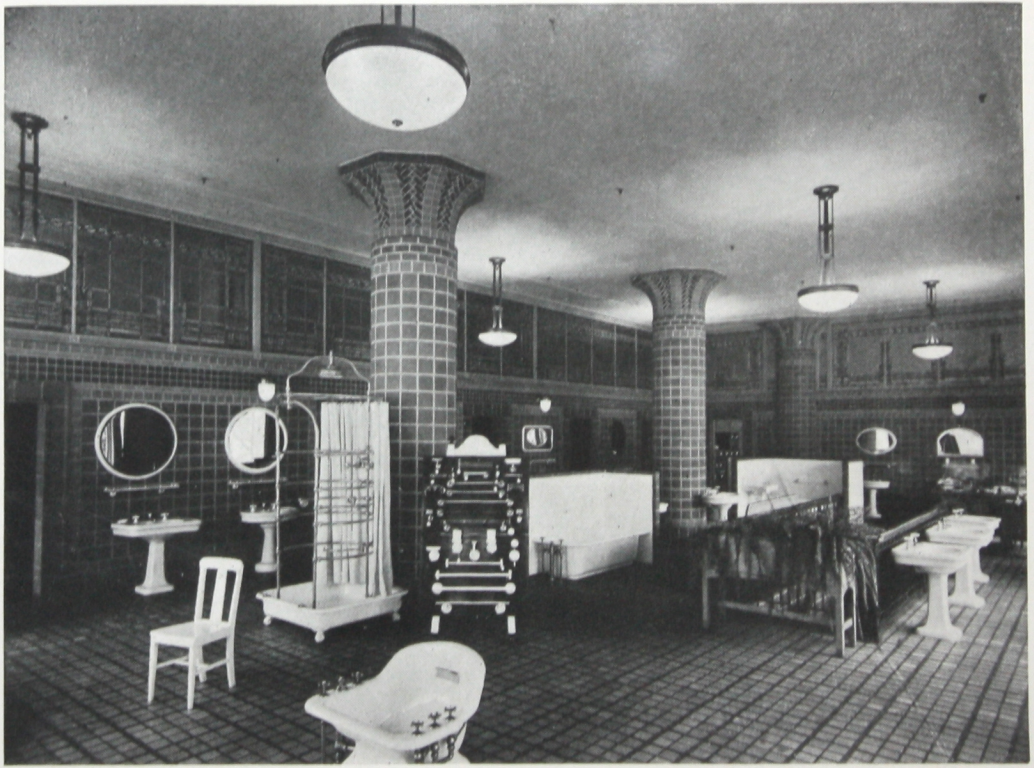

Fig. 15—An Exceptionally Well Lighted Display Room. Note the Absence of Sharp Contrasts

exceed 20¼ feet if uniform illumination is to be obtained. Since the maximum distance between units if one is placed in the center of each bay is 21½ feet, the requirements for uniformity are sufficiently well fulfilled.

How far the units would be suspended from the ceiling would be determined largely by considerations of appearance; this would involve not only the appearance of the unit with respect to the store as a whole, but the appearance of the ceiling with the units lighted. Shadows of chains and of the bowl upon the ceiling if pronounced could be eliminated by etching the lamps.

Lamps

MAZDA lamps embodying the gas-filled construction should be used in practically all cases, for they are particularly adapted to store lighting. Their efficiency is high, their operation is simple, and the range of sizes is such that suitable lamps may be secured for every requirement.

The filaments of gas-filled MAZDA lamps operate at a considerably higher temperature than do those of vacuum MAZDA lamps. In consequence of this, gas-filled lamps not only operate more efficiently, but give light of a whiter color quality. This dual advantage has made practical the design of gas-filled MAZDA lamps to produce light of afternoon sunlight quality at an efficiency which is comparable with the efficiency of vacuum MAZDA lamps. The simplicity which has always characterized incandescent lamps has not been sacrificed in any particular in securing this result. Scientifically selected coloring elements, melted with the ingredients which form the glass from which the bulbs are blown, serve to filter out the excess red and yellow rays emitted by the filament, leaving a light in which the colors are found in the same proportion as they are found in afternoon sunlight. In this bulletin, clear MAZDA lamps of the gas-filled construction have been designated as MAZDA C lamps to distinguish them from vacuum lamps to which the designation MAZDA B has been given; gas-filled MAZDA lamps which give light of afternoon sunlight quality are known as MAZDA C-2 lamps. *It should be noted that MAZDA C-2 lamps are not designed for color matching purposes.

*MAZDA C-2 lamps, which give light of afternoon sunlight quality, should not be confused with MAZDA C-3 lamps, which are designed to give a light adapted particularly to photography, nor with color-matching units in which are used MAZDA C lamps and a special filter plate forming part of the fixture to produce a light of true north-sky quality for accurate color matching. The light of these three units is very different in spectral character.

The possibilities which MAZDA C-2 lamps present in all fields of illumination are nowhere of greater moment than in store lighting. The appearance of objects is very largely dependent upon the color quality of the light by which they are seen. A woman in selecting fabrics invariably prefers to see them in daylight. The same is true of a man in regard to his clothing.

It is by bringing light of daylight quality to the counter, to the display room, to all places, in fact, where the proper rendition of color is necessary or desirable that MAZDA C-2 lamps fill a need long felt in artificial lighting.

Notwithstanding the fact that daylight quality of artificial lighting is so greatly in demand, some objection may be felt to the "cold" effect which is more or less noticeable by contrast with the "warm" effect of yellower illuminants. Warm effects may, however, be secured, where desirable, in a MAZDA C-2 installation by supplying a warm background—that is, by using reds, yellows, and browns in the decorations—or by using warm tints in the lower portion of the enclosing glassware. In this way, the wares are displayed in approximately their daylight color values, without the effect of coldness being produced. Interior decorations have necessarily in the past always been designed to appear at their best under artificial light of a yellowish color; with the development of the MAZDA C-2 lamp the restrictions which have limited the efforts of architects and designers are removed. It is probable that the use of color in lighting will mark an epoch in the art of interior decoration.

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June 5, 1917

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8F Miniature MAZDA Lamps.

10D Essentials of Train Lighting.

11C Street Series MAZDA Lamps.

13E Multiple MAZDA Lamps.

15A Engineering Features of Electric Sign Lighting.

15B Lighting of Billboards and Large Painted Signs.

20 Industrial Lighting (With Supplement).

21 The Successful Handling of the Small Consumer in Europe.

22 Show Case Lighting.

23 MAZDA Lamps for Projection Purposes.

24 Outdoor Tennis Court Lighting.

25 Street Series Alternating-Current Incandescent Lamp Circuits.

26 The MAZDA Lamp in Photography.

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29 Store Lighting.

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